

WHAT IS CLAIMED IS:

- 1 1. A process for synthesizing photocurable
2 poly(ethynyl)carbosilane comprising the steps of:
3 a. mixing dichlorosilane and trichlorosilane reagents;
4 b. adding sub-stoichiometric amounts of alkali metal; and
5 c. adding excess sodium acetylide.
6
- 7 2. A process for synthesizing photocurable
8 poly(ethynyl)carbosilane comprising the steps of:
9 a. mixing dichlorosilane and trichlorosilane reagents in the
10 presence of methylene bromide;
11 b. adding sub-stoichiometric amounts of alkali metal; and
12 c. adding excess sodium acetylide.
13
- 14 3. A process for synthesizing photocurable poly(ethynyl)
15 carbosilane comprising the steps of:
16 a. mixing dichlorosilane and trichlorosilane reagents in the
17 presence of methylene bromide;

- 1 6. A process for synthesizing photocurable poly(ethynyl)
- 2 carbosilane comprising the steps of:
- 3 a. forming a dispersion of sub-stoichiometric amounts of
- 4 alkali metal;
- 5 b. adding dichlorosilane and trichlorosilane reagents; and
- 6 c. adding excess sodium acetylide.
- 7
- 8 7. A process for synthesizing photocurable poly(ethynyl)
- 9 carbosilane comprising the steps of:
- 10 a. forming a dispersion of sub-stoichiometric amounts of
- 11 molten sodium metal in a solvent;
- 12 b. adding dichlorosilane and trichlorosilane reagents; and
- 13 c. adding excess sodium acetylide.
- 14
- 15 8. A process for synthesizing photocurable poly(ethynyl)
- 16 carbosilane comprising the steps of:
- 17 a. forming a dispersion of sub-stoichiometric amounts of
- 18 molten sodium metal in a solvent;

- 1 b. adding dichloromethylsilane and trichlorophenylsilane
- 2 reagents; and
- 3 c. adding excess sodium acetylide in dimethylbromide.
- 4
- 5 9. A process for synthesizing photocurable poly(ethynyl)
- 6 carbosilane comprising the steps of:
- 7 a. forming a dispersion of sub-stoichiometric amounts of
- 8 molten sodium metal in xylene;
- 9 b. adding dichloromethylsilane and trichlorophenylsilane
- 10 reagents; and
- 11 c. adding excess sodium acetylide in dimethylbromide.
- 12
- 13 10. A process for synthesizing photocurable poly(ethynyl)
- 14 carbosilane comprising the steps of:
- 15 a. forming a dispersion of sub-stoichiometric amounts of
- 16 molten sodium metal in xylene;
- 17 b. adding dichloromethylsilane and trichlorophenylsilane
- 18 reagents;

- 1 c. filtrating insoluble by-products;
- 2 d. evaporating xylene solvent from poly(chloro)carbosilane
- 3 polymer;
- 4 e. dissolving said aforementioned polymer in tetrahydro
- 5 furan; and
- 6 f. adding excess sodium acetylide dissolved in dimethyl
- 7 bromide.

- 8
- 9 11. A process of forming a photo-curable pre-ceramic
- 10 polymer, poly(ethynyl)-carbosilane to silicon carbide
- 11 ceramic comprising the steps of:
- 12 a. reacting sodium acetylide with organo-chlorosilanes;
- 13 and
- 14 b. condensing (polymerizing) the resultant organo-
- 15 (ethynyl)chlorosilane product of step a with an excess
- 16 of an alkali metal.

- 17 12. A process of forming a photo-curable pre-ceramic

1 polymer, poly(ethynyl)-carbosilane to silicon carbide
 2 ceramic comprising the steps of:
 3 a. reacting sodium acetylide with organochloro-silanes;
 4 and
 5 b. condensing (polymerizing) the resultant organo-
 6 ethynyl)chlorosilane product of step a with an excess of
 7 an alkali metal sodium.

8 13. A process of forming a photo-curable pre-ceramic
 9 polymer, poly(ethynyl)-carbosilane, to silicon carbide
 10 ceramic comprising the steps of:
 11 a. reacting sodium acetylide with a mixture of
 12 organodichlorosilanes and organotrichlorosilanes;
 13 and
 14 b. condensing (polymerizing) the resultant organo
 15 (ethynyl)-chlorosilane product of step a with an excess
 16 of an alkali metal.
 17

1 14. A process according to claim 1 in which the organo
2 chlorosilane is selected from a group of one or more of the
3 following: dichlorodimethylsilane, trichloro-phenylsilane
4 (tri-functional), and methyltrichlorosilane.

5
6 15. A process of forming a photo-curable pre-ceramic
7 polymer, poly(ethynyl)-carbosilane to silicon carbide
8 ceramic comprising the steps of:

- 9 a. reacting a sub-stoichiometric amount of an alkali metal
- 10 with organochloro-silanes; and
- 11 b. reacting the partially polymerized polyorganochloro-
- 12 silane with sodium acetylide.

13
14 16. A process of forming a photo-curable pre-ceramic
15 polymer, poly(ethynyl)- carbosilane to silicon carbide
16 ceramic comprising the steps of:

- 17 a. reacting a sub-stoichiometric amount of sodium metal
- 18 with organochlorosilanes; and

- 1 b. reacting the partially polymerized polyorganochloro-
- 2 silane with sodium acetylide.
- 3
- 4 17. A process of forming a photo-curable pre-ceramic
- 5 polymer, poly(ethynyl)carbosilane to silicon carbide ceramic
- 6 comprising the steps of:
- 7 a. reacting a sub-stoichiometric amount of an alkali
- 8 metal with a mixture of organodichlorosilanes and
- 9 organotrichlorosilanes; and
- 10 b. reacting the partially polymerized polyorgano-
- 11 chlorosilane with sodium acetylide.
- 12
- 13 18.A process according to claim 5 in which the
- 14 organochlorosilane is selected from a group consisting
- 15 of one or more of the following: dichlorodimethylsilane,
- 16 trichlorophenylsilane (tri-functional), and
- 17 methyltrichlorosilane.
- 18

1 19. A process of forming a photo-curable pre-ceramic
2 polymer, poly(ethynyl)silazane, to silicon nitride ceramic
3 comprising the steps of:

- 4 a. reacting sodium acetylide with organochlorosilanes;
- 5 and
- 6 b. condensing (polymerizing) the resultant organo-
- 7 (ethynyl)chlorosilane product of step a with ammonia.

8
9 20. A process of forming a photo-curable pre-ceramic
10 polymer, poly(ethynyl)-silazane to silicon nitride ceramic
11 comprising the steps of:

- 12 a. reacting sodium acetylide with organochloro-
- 13 silanes; and
- 14 b. condensing (polymerizing) the resultant organo-
- 15 (ethynyl) chlorosilane product of step a with ammonia.

16
17 21. The process of preparing photocurable CERASETTM SZ
18 inorganic polymer comprising the step adding a photo-

1 initiator to CERASETTM SZ inorganic polymer.

2

3 22. The process of claim 21, in which said photo-initiator
4 is Camphorquinone.

5

6 23. The process of claim 21 in which said photo-initiator is
7 IRGACURE® 1800.

8

9 24. The process of preparing photocurable allylhydrido-
10 polycarbosilane polymer comprising the step of adding a
11 photo-initiator to allylhydridopolycarbosilane polymer.

12

13 25. The process of claim 24, in which said photo-initiator
14 is Camphorquinone.

15

16 26. The process of claim 24, in which said photo-initiator
17 is IRGACURE® 1800.

18

1 27. A process of forming a photo-curable pre-ceramic
2 polymer, poly(ethynyl)silazane, to silicon nitride ceramic
3 comprising the steps of:

- 4 a. reacting sodium acetylide with a mixture of organo-
5 dichlorosilanes and organotrichlorosilanes; and
- 6 b. condensing (polymerizing) the resultant organo-
7 (ethynyl)chloro-silane product of step a with ammonia.

8
9 28. A process according to claim 27 in which the
10 organochlorosilane is selected from a group consisting of
11 one or more of the following: dichlorodimethylsilane,
12 trichlorophenylsilane (tri-functional) and methyltri
13 chlorosilane.

14
15 29. A process of forming a photo-curable pre-ceramic
16 polymer, poly(ethynyl)-silazane to silicon nitride ceramic
17 comprising the steps of:

- 18 a. reacting a sub-stoichiometric amount of ammonia

- 1 organotrichlorosilanes; and
- 2 b. reacting the partially polymerized polyorganoc
- 3 hlorosilazane with sodium acetylide.
- 4
- 5 32. A process for fabricating a ceramic matrix composites
- 6 comprising the steps of:
- 7 a. preparing a solution of thermoplastic photo-curable
- 8 pre-ceramic polymer;
- 9 b. passing a pre-preg through said solution of
- 10 thermoplastic photo-curable pre-ceramic polymer;
- 11 c. applying said pre-preg to a shaped mandrel;
- 12 d. using light energy to induce cross-linking of said
- 13 photo-curable pre-ceramic polymer after application to
- 14 said mandrel whereby said thermoplastic pre-ceramic
- 15 polymer is curved; and
- 16 e. pyrolyzing said cured thermoplastic pre-ceramic
- 17 polymer matrix composite material.

- 1 33. A single-step fabrication of continuous ceramic fiber
2 ceramic matrix composites employing a thermoplastic
3 photo-curable pre-ceramic polymer in which the component is
4 shape by a variety of standard composite fabrication
5 techniques, such as filament winding, tape winding, and
6 woven cloth winding comprising steps of:
- 7 a. passing ceramic fiber monofilament, tow, mat, or
8 woven cloth through a solution of said thermoplastic
9 photo-curable pre-ceramic polymer;
 - 10 aa. applying ceramic fiber monofilament, tow, mat, or
11 woven cloth to a shaped mandrel;
 - 12 bb. using photo-energy of the ultraviolet, visible or
13 infrared light spectrum to induce cross-linking
14 (curing) of the photo-curable pre-ceramic polymer
15 after application to said mandrel; and
 - 16 cc. either partially or completely pyrolyzing the now
17 cured pre-ceramic polymer matrix composite
18 material.

1 35. A process for synthesizing ceramic matrix composites
2 according to claim 34 in which the pre-ceramic polymer is
3 poly(ethynyl)carbosilane.

36. A process for synthesizing ceramic matrix composites
according to claim 34 in which the pre-ceramic polymer
yields silicon carbide upon pyrolysis.

9 37. A process for synthesizing ceramic matrix composites
10 according to claim 34 in which the pre-ceramic polymer
11 yields an oxide ceramic upon pyrolysis.

13 38. A process for synthesizing ceramic matrix composites
14 according to claim 34 in which the pre-ceramic polymer
15 yields titanium carbide upon pyrolysis.

17 39. A process for synthesizing ceramic matrix composites
18 according to claim 34 in which the pre-ceramic polymer

1 yields aluminum nitride upon pyrolysis.

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3 40. A process for synthesizing ceramic matrix composites
4 according to claim 34 in which the pre-ceramic polymer
5 yields silicon nitride upon pyrolysis.

6

7 41. A process for synthesizing ceramic matrix composites
8 according to claim 34 in which the pre-ceramic polymer
9 yields aluminum oxide upon pyrolysis.

10

11 42. Single-step fabrication of continuous ceramic fiber
12 ceramic matrix composites employing a thermoplastic
13 photo-curable pre-ceramic polymer in which the component is
14 shape by a variety of standard composite fabrication
15 techniques, such as filament winding, tape winding, and
16 woven cloth winding under inert atmosphere comprising steps
17 of:

18 a. passing ceramic fiber monofilament, tow, mat, or

1 woven cloth through a solution of said thermoplastic
2 photo-curable pre-ceramic polymer;
3 b. applying ceramic fiber monofilament, tow, mat, or
4 woven cloth to a shaped rotating mandrel;
5 c. use of a heated or unheated compaction roller to
6 press the thermoplastic pre-ceramic polymer onto the
7 mandrel;
8 d. using ultraviolet, visible, or infrared light to
9 induce cross-linking (curing) of the photo-curable pre-
10 ceramic polymer thereby rendering a thermoset polymer;
11 e. either partially or completely pyrolyzing the now
12 cured pre-ceramic polymer matrix material; and
13 f. followed by the final heat treatment of the shaped
14 ceramic matrix composite "brown body".
15
16 43. A process for synthesizing ceramic matrix composites
17 according to claim 42 in which the pre-ceramic polymer is
18 poly(ethynyl)carbosilane.

1 44. A process for synthesizing ceramic matrix composites
2 according to claim 42 in which the pre-ceramic polymer
3 yields an oxide ceramic upon pyrolysis.

4

5 45. A process for synthesizing ceramic matrix composites
6 according to claim 42 in which the pre-ceramic polymer
7 yields silicon nitride upon pyrolysis.

8

9 46. A process for synthesizing ceramic matrix composites
10 according to claim 42 in which the pre-ceramic polymer
11 yields titanium carbide upon pyrolysis.

12

13 47. A process for synthesizing ceramic matrix composites
14 according to claim 42 in which the pre-ceramic polymer
15 yields aluminum nitride upon pyrolysis.

16

17 48. A process for synthesizing ceramic matrix composites
18 according to claim 42 in which the pre-ceramic polymer

1 yields silicon carbide upon pyrolysis.

2

3 49. A process for synthesizing ceramic matrix composites
4 according to claim 42 in which the pre-ceramic polymer
5 yields aluminum oxide upon pyrolysis.

6

7 50. Single-step fabrication of continuous ceramic fiber
8 ceramic matrix composites employing a thermoplastic
9 photo-curable pre-ceramic polymer in which the component is
10 shape by a variety of standard composite fabrication
11 techniques, such as filament winding, tape winding, and
12 woven cloth winding, comprising steps of:

- 13 a. passing ceramic fiber monofilament, tow, mat, or
- 14 woven cloth through a solution of said thermoplastic
- 15 photo-curable pre-ceramic polymer;
- 16 b. applying ceramic fiber monofilament, tow, mat, or
- 17 woven cloth to a moving flat substrate;
- 18 c. using a compaction roller to press the thermo-

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1 plastic pre-ceramic polymer coated ceramic fiber onto
2 flat substrate;
3 d. using photo-light of the ultraviolet, visible, or
4 infrared light spectrum to induce cross-linking curing)
5 of the photo-curable pre-ceramic polymer thereby
6 rendering a thermoset polymer; and
7 e. either partially or completely pyrolyzing the now
8 cured pre-ceramic polymer matrix coated ceramic fiber
9 material.

10

11 51. A process for synthesizing ceramic matrix composites
12 according to claim 50 in which the pre-ceramic polymer is
13 poly(ethynyl)carbosilane.

14

15 52. A process for synthesizing ceramic matrix composites
16 according to claim 50 in which the pre-ceramic polymer
17 yields an oxide ceramic upon pyrolysis.

18

1 53. A process for synthesizing ceramic matrix composites
2 according to claim 50 in which the pre-ceramic polymer
3 yields silicon nitride upon pyrolysis.

4

5 54. A process for synthesizing ceramic matrix composites
6 according to claim 50 in which the pre-ceramic polymer
7 yields titanium carbide upon pyrolysis.

8

9 55. A process for synthesizing ceramic matrix composites
10 according to claim 50 in which the pre-ceramic polymer
11 yields aluminum nitride upon pyrolysis.

12 56. A process for synthesizing ceramic matrix composites
13 according to claim 50 in which the pre-ceramic polymer
14 yields silicon carbide upon pyrolysis.

15

16 57. A process for synthesizing ceramic matrix composites
17 according to claim 50 in which the pre-ceramic polymer
18 yields aluminum oxide upon pyrolysis.